



NOTES

STAPHYLOCOCCUS

MICROBE OVERVIEW

- *Staphylococcus*: genus of Gram-positive bacteria responsible for many diseases
- Aerobic, facultative anaerobic
- **Frequent skin colonization**: up to half of population

Genetic material

- All staphylococci are catalase-positive

Taxonomy

- Staphylo-: cluster; -coccus: berry

Morphology

- Organized in grape-like clusters
- **Gram stain**: round, Gram-positive (purple)

bacteria; thick peptidoglycan cell wall

Antibiotic resistance mechanisms

- β -lactamase: hydrolysis of β -lactam antibiotics; some β -lactam antibiotics are resistant to the enzyme (e.g. oxacillin, nafcillin, flucloxacillin)
- *mecA* gene $\rightarrow$ penicillin binding protein (PBP2a) $\rightarrow$ reduced affinity for β -lactam antibiotics; present in methicillin-resistant strains
- *vanA* gene $\rightarrow$ modifies cell wall peptidoglycans $\rightarrow$ vancomycin cannot bind to bacteria

STAPHYLOCOCCUS AUREUS

osms.it/staphylococcus-aureus

PATHOLOGY & CAUSES

- *Staphylococcus aureus*: common bacterium, causes infections in most organ systems
- **Aureus**: golden colonies in mannitol salt agar, due to mannitol fermentation
- **Skin colonization**: approx. 30% of population
 - **Primary colonization site**: nostrils
- **Pathogen transmission**: direct contact, fomites

Virulence factors

- **Cytolysins**: alpha-toxin, Panton-Valentine leukocidin (PVL); both destroy neutrophils
 - PVL related to severe skin, lung infections

- **Hemolysins**: form pores in host cells (e.g. erythrocytes, macrophages, lymphocytes)
- **Superantigens**: enterotoxins, toxic shock syndrome toxin-1 (TSST-1)
 - Superantigens stimulate activation of excessive amount of T-cells $\rightarrow$ increased production of cytokines $\rightarrow$ uncontrolled inflammation
- **Epidermolytic toxins A and B**: skin blistering
- **Coagulase**: activates prothrombin $\rightarrow$ coagulation
- **Bacterial spread**: protease degrades proteins; lipase degrades lipids
- **Protein A**: inactivates immunoglobulins $\rightarrow$ phagocytosis evasion
- Can form biofilms
 - **Biofilm**: adherence of cells to polymer

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- surfaces (e.g. catheters)
- Properties allow immune evasion

CAUSES

- Common cause of infections and toxin-mediated diseases **acquired from community/healthcare environment**
 - Endocarditis, ocular infections, pneumonia, meningitis, osteomyelitis, septic arthritis, prosthetic device infections, catheter-associated infections

Skin/soft tissue infections

- E.g. surgical site infections, abscesses, impetigo, cellulitis, erysipela, fasciitis, mastitis

Toxic shock syndrome (TSS)

- Mediated by toxic shock syndrome toxin-1; commonly caused by growth of *S. aureus* in vagina/surgical sites → multiple organ dysfunction

Staphylococcal scalded-skin syndrome (Ritter disease)

- Mediated by epidermolytic toxins A and B

Foodborne illness

- Caused by ingestion of *S. aureus* endotoxins

RISK FACTORS

- Immunosuppression, IV drug use, recent invasive procedure, foreign material in body (e.g. prosthetics, catheters, sutures), dialysis

COMPLICATIONS

- Sepsis, bacteremia, invasive infection
- Antibiotic resistance:** all strains resistant to penicillin G; some strains resistant to methicillin (MRSA) or vancomycin (VRSA); some strains have intermediate resistance to vancomycin (VISA)
 - Resistant strains are common pathogens in nosocomial infections

SIGNS & SYMPTOMS

Skin/soft tissue infections

- Erythema, swelling, warmth, localized warmth/fever
 - **Staphylococcal scalded-skin syndrome (Ritter disease):** fever, erythema, fluid-filled bullae on the skin → skin loss

Systemic infections

- Joint pain, abdominal pain, headache, CVA tenderness, new onset heart murmur

TSS

- Fever, hypotension, rash, coagulopathy, tissue necrosis (site of infection)

Foodborne illness

- Nausea, vomiting, diarrhea, abdominal pain

DIAGNOSIS

LAB RESULTS

- Culture-based observation
 - Clustered golden Gram-positive cocci
 - Catalase-positive; coagulase-positive
- Polymerase chain reaction (PCR) amplification
- May be guided by further studies depending on site of infection

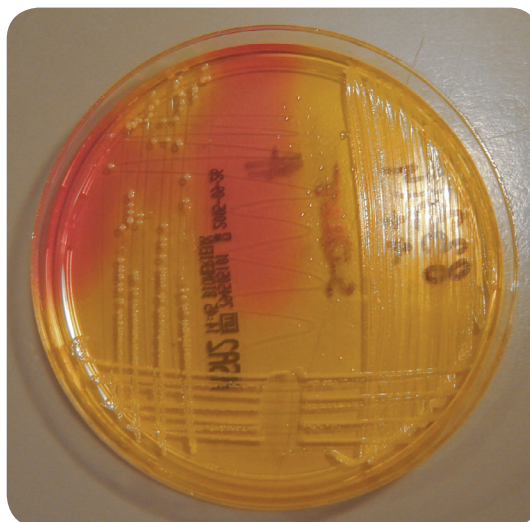


Figure 98.1 *Staphylococcus* takes on a golden colour when cultured with mannitol containing media.

TREATMENT

MEDICATIONS

Topical antibiotics

- Superficial skin infections

Oral/IV antibiotics

- Treatment based on the pathogen's antibiotic susceptibility

- Oxacillin/nafcillin/cefazolin
- MRSA: vancomycin/trimethoprim-sulfamethoxazole
- VRSA: linezolid

SURGERY

- Abscess drainage (if applicable)
- Foreign material removal in body (if applicable)

STAPHYLOCOCCUS EPIDERMIDIS

osms.it/staphylococcus-epidermidis

PATHOLOGY & CAUSES

- *Staphylococcus epidermidis*: bacteria commonly associated with infections of surgical sites, indwelling catheters, and prosthetic devices
- Part of skin and mucous membrane natural flora
- Does not produce exotoxins

CAUSES

- Skin/mucous colonization → barrier rupture → infection
- Can form biofilms on foreign materials in body; biofilm properties allow immune evasion
- Polymer surface adhesion → extracellular matrix production → polysaccharide intercellular adhesin (PIA) secretion → multi-layered bacteria
- Common *S. epidermidis* infections: catheter-associated infection, intravascular catheter infection, prosthetic joint infection, endocarditis (frequently associated with prosthetic valves), surgical site infection

RISK FACTORS

- Immunosuppression, neonates, recent invasive procedure, foreign material in the body (e.g. prosthetics, catheters), dialysis

COMPLICATIONS

- Sepsis, bacteremia
- Neonates: pneumonia, urinary tract infections, meningitis, enterocolitis, omphalitis

SIGNS & SYMPTOMS

Local

- Pain, tenderness, swelling, warmth, erythema, drainage at incisional site

Systemic

- Fever, hypotension, leukocytosis

DIAGNOSIS

LAB RESULTS

Culture-based observation

- Blood, urine, synovial fluid, surgical site
 - Clustered Gram-positive cocci
 - Catalase-positive; coagulase-negative; novobiocin-sensitive

PCR amplification

TREATMENT

MEDICATIONS

Oral antibiotics

- Empiric treatment: vancomycin
- If proven methicillin sensitivity: oxacillin/nafcillin; may be combined with rifampicin, gentamicin
- Fusidic acid for skin infections (if available)

SURGERY

- Remove foreign material from body (if applicable)

STAPHYLOCOCCUS SAPROPHYTICUS

osms.it/staphylococcus-saprophyticus

PATHOLOGY & CAUSES

- *Staphylococcus saprophyticus*: bacteria that commonly produces urinary tract infections (UTI) in young, biologically-female individuals
- Frequently part of vagina's natural flora
- Tropism for urinary tract: surface fibrillar protein (Ssp) and hemagglutinin/adhesin allow pathogen's adherence to uroepithelial cells
- Does not produce exotoxins
- Etiologic agent: community-acquired UTIs (occasionally)
- Usually presents as symptomatic cystitis (bladder inflammation)

RISK FACTORS

- Biologically-female (shorter urethra), recent sexual activity ("honeymoon cystitis"), diabetes, immunosuppression, indwelling urinary catheter

COMPLICATIONS

- Pyelonephritis

SIGNS & SYMPTOMS

- Dysuria (painful urination), urinary urgency, increased urinary frequency, suprapubic pain, occasional hematuria

DIAGNOSIS

LAB RESULTS

Urinalysis

- Presence of leukocytes, erythrocytes, bacteria, negative urine nitrate

Culture-based observation

- Clustered Gram-positive cocci
- Catalase-positive; coagulase-negative; novobiocin-resistant

Quantitative PCR

TREATMENT

MEDICATIONS

- Oral antibiotics
- Symptomatic therapy (e.g. phenazopyridine)